LANDSLIDE MAPPING: IMPROVING ACCURACY AND EFFICIENCY

Michele Santangelo [(1,2)]; Ivan Marchesini [(1)], Francesco Bucci [(1)], Federica Fiorucci [(1)], Mauro Cardinali [(1)] and Fausto Guzzetti [(1)]

(1) CNR IRPI, Via della Madonna Alta 126, Perugia, Italy. michele.santangelo@irpi.cnr.it
(2) Università degli Studi di Perugia, Piazza dell'Università 1, Perugia, Italy

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INTRODUCTION

Landslide inventory maps are a key issue to document the type and extent of mass movements in small (slope scale) to very large (country scale) areas, for geomorphological studies, and for landslide hazard and risk assessment (Guzzetti et al, 2012 and references therein). Geomorphologists usually prepare landslide inventories by aerial photo interpretation (API) of stereoscopic images aided by field survey. Criteria adopted for the visual image analysis derive from the heuristic interpretation of photographic and morphological features of the image, such as shape, size, colour tone, texture and pattern. An established procedure for transferring photo-interpreted information to a GIS environment is traditionally organized according to the following stages: (i) landslide information are drawn directly on an undeformable plastic film superimposed to the aerial photograph, (ii) the interpreted data are transferred on a plastic sheet superimposed to the topographic map, (iii) the photo-interpreted layer is scanned, imported and georeferenced as a raster file in a GIS project (iv) geomorphological elements are manually digitized and encoded through the compilation of a geo-database. This traditional method is time consuming, resource demanding, and depends on the experience of the geomorphologist. As a result, landslide inventory maps can be affected by mapping errors (positioning and shape) of the single landslides (Ardizzone et al., 2002).

We recently explored new GIS applications and tools that can help geomorphologists to digitize, store and publish landslide data more accurately and efficiently. We developed and tested a procedure that exploits GIS applications for the digitization and storing phase, and GeoServer for the creation of web-gis services.

In this work we describe the new procedure and compare it to the traditional method. Advantages and needed further developments are also highlighted.

MATERIALS AND METHOD

The new method developes starting from the API analysis, and is organized in the following steps: (i) ortho-rectification of the aerial photograph and its geomorphological elements; (ii) raster tracing of the geomorphological elements portrayed on the image; (iii) compilation of a geodatabase; (iv) publication of the features on a web-gis service. The former step exploits the GRASS GIS script i.ortho.photo. The script requires a number of input data, such as the scanning of the aerial photograph (Fig. 1A) and the superimposed undeformable plastic film, a DTM, an orthophoto map, and the camera parameters of the aerial photograph (Rocchini et al, 2010). Figure 1B shows the result of the ortho-rectification step. For the raster tracing step, we exploited ArcScan extension of ArcGIS 10, which provides a number of tools for raster to vector data conversion. Input file is a grid raster file (1 bit) of the only geomorphologic features. Vector features (lines and polygons) are stored in output shapefiles.

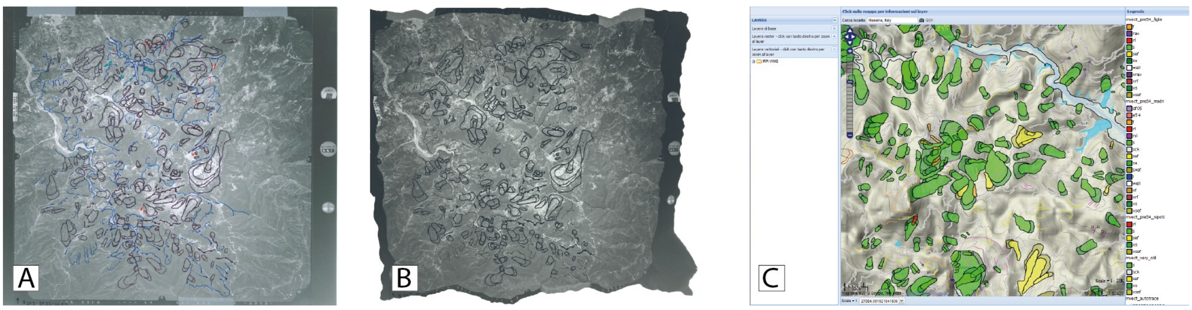

Figure 1 – (A) IGM b/w aerial photograph. Result of the visual interpretation is portrayed. (B) Orthorectified aerial photograph. (C) Web-gis screenshot.

For the third step, which is common to the traditional procedure, a geographical database is is compiled according to the photo-interpreted information. Both proprietary and open source GIS software can be used. Finally, the ortho-rectified aerial photographs (raster files), and the shapefiles of the geomorphologic features, are loaded on a relational database with geographical extension (PostgreSQL/PostGIS). For this operation SLD (Style Layer Description) styles need to be associated to the shapefiles. Then, WMS services are generated by GeoServer, and WMS layers are loaded on a web-gis project (Fig. 1C).

RESULTS AND CONCLUSIONS

A landslide inventory map was prepared for the same area adopting the traditional and the new method. To compare the resulting maps, we used for reference a topographic base map 1:10.000 scale. Figure 2 summarizes the mismatch between the two inventories. Some of the landslides were mapped in a slightly different geographical location and have a comparable area (landslides (e) and (f) in Fig. 2). For landslides (a) and (d) positional mismatch is acceptable, while landslide area was overestimated following the traditional approach. Lastly, for landslides (b) and (c) dimension and positional mismatch results unacceptable.

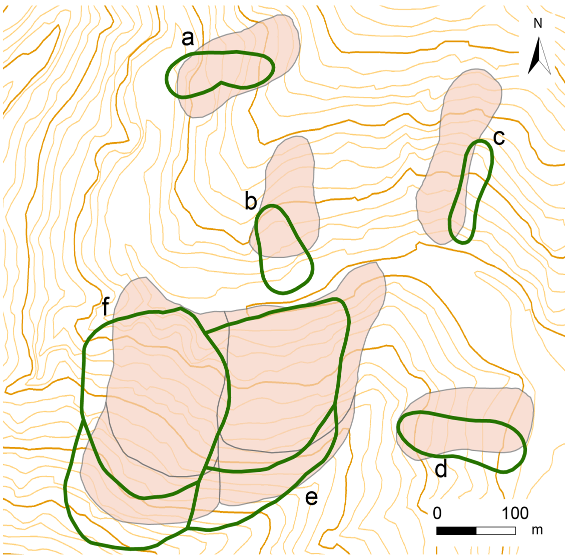

Figure 2 – Comparison of landslide mapping following the traditional procedure (pink polygons) and the new procedure (green lines). Letters from (a) to (e) indicate single landslides.

Visual comparison of the two inventories reveals that the extent of smaller landslides ((a), (b), (c), (d) in Fig. 2) is overestimated in the inventory carried out using the traditional procedure. As a result, landslide frequency-area statistics (Malamud et al., 2004) derived using the two procedures could be slightly different.

Lastly, comparison of the landslide inventories prepared by the two different methods revealed that the traditional method introduces errors that can affect the evaluation of landslide susceptibility, hazard, vulnerability and risk.

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